

OCT 26 1979

Payload Data Package ANNEX

(NASA-TM-80825) PAYLOAD DATA PACKAGE:
TRACKING AND DATA RELAY SATELLITE SYSTEM
(TDRS) (NASA) 26 p

N80-70432

Unclassified
00/16 39659

Tracking and Data Relay Satellite System (TDRS)

Revision 1
October 1979

FOR INFORMATION ONLY
(these data have not been baselined)



National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas

ABSTRACT

The TDRS Spacecraft are to be integrated and launched by the STS/IUS system and placed into a geosynchronous orbit from the Eastern Launch Site. This document provides the basic payload data (IUS, TDRS and ASE) to be used in the Payload Data Package Annex to JSC 14019.

KEY WORDS

Spacecraft (TDRS)
Inertial Upper Stage (IUS)
Space Transportation Systems (STS)
Space Shuttle Vehicle (SSV)
Airborn Support Equipment (ASE)

Orbiter

PREFACE

This document contains the basic payload data on the Tracking and Data Relay Satellite System payload (TDRS) and is issued as an annex to the Payload Integration Plan for TDRS (JSC 14019 Annex #1).

This annex is the single authoritative source for TDRS payload data of the types designated herein. All data presented in this annex should be considered preliminary. Corrections and updates will be made as necessary with the next planned update publication being made as soon as all data are verified and approved by the Payload Manager and his staff.

Comments and corrections to these data as well as requests for additional data should be directed to E. Dixon Murrah, WC6, NASA-JSC, telephone 713-483-5927.

CONTENTS

Section	Page
ABSTRACT	i
PREFACE	ii
1.0 PAYLOAD SEQUENCED MASS PROPERTIES	1
1.1 Launch Configuration - Mass Properties	1
1.2 Deployment Configuration - Mass Properties	1
1.3 ASE Return Configuration - Mass Properties	1
2.0 CONFIGURATION DRAWINGS	4
2.1 Integrated ASE/IUS/TDRS	4
3.0 RF RADIATION DATA	13
3.1 Transmitting System	13
3.1.1 IUS Transmission (RF)	13
3.1.2 TDRS Transmission (RF)	14
3.2 Receiving System	14
3.2.1 IUS Reception (RF)	15
3.2.2 TDRS Reception (RF)	16
3.3 TDRS Antenna System	17
3.4 TDRS Omni Antenna Coverage (Stowed Case)	17
4.0 TDRS/IUS ERECTION DATA	20
4.1 IUS Deployment Data	20
5.0 ATTITUDE INITIALIZATION	20

FIGURES

Figure	Page
1-1 ASE/IUS/TDRS Mass Properties (Launch)	2
1-2 ASE/IUS/TDRS mass Properties (Deployment)	2
1-3 ASE Mass Properties (Return)	2
2-1 Integrated ASE/IUS/TDRS Configuration	5
2-2 TDRS Configuration	7
2-3 IUS Configuration	9
2-4 ASE Configuration	10
2-5 IUS Antenna Implementation	12
2-6 Cut thru XZ plane (stowed case)	18
2-7 Cut thru YZ plane (stowed case)	19
4-1 Ejection spacing location	21
5-1 IUS Star Tracker F.O.V./Orientation	22

TABLES

Table	Page
1-1 ASE/IUS/TDRS MASS PROPERTY CHARACTERISTICS	3
4-1 PAYLOAD ERECTION DATA	20
5-1 IUS STAR CATALOG	23

1.0 PAYLOAD SEQUENCED MASS PROPERTIES

Mass properties for the ASE/IUS/TDRS payload are delineated in the following subparagraphs with respect to their characteristics during the normal mission sequencing (IUS/TDRS deployed from Orbiter).

In the case of a mission abort (IUS/TDRS not deployed), the payload launch configuration mass properties are to be used for Orbiter landing.

1.1 Launch Configuration - Mass Properties

The integrated ASE/IUS/TDRS payload configuration (exclusive of ASE not located in Orbiter bay) at launch is shown in Figure 1-1. Table 1-1 reflects the mass properties of the complete payload.

1.2 Deployment Configuration - Mass Properties

The payload configuration at IUS/TDRS deployment from the Orbiter is represented by Figure 1-2. The C.G. location at deployment is denoted on the figure.

1.3 ASE Return Configuration - Mass Properties

The ASE configuration during a normal Orbiter mission landing (IUS/TDRS deployed) is shown in Figure 1-3. Table 1-1 reflects the mass properties of the returned ASE.

NOTE: Mass properties for above payload includes estimated modifications to IUS generic design (ICD-A-81200) that are required by TDRS mission specifics (i.e., additional batteries, wiring, etc.)

NOTE: CENTERLINE AT ORBITER $Z_0 = 400$
 Y_O, Y_I ON STARBOARD
 CG AT 1057.8 (ORBITER)

STATIONS	
ORBITER	IUS
A - 758.57	610
B - 989.8	379
C - 1010.0	359
D - 1139.8	229
E - 1190.8	178

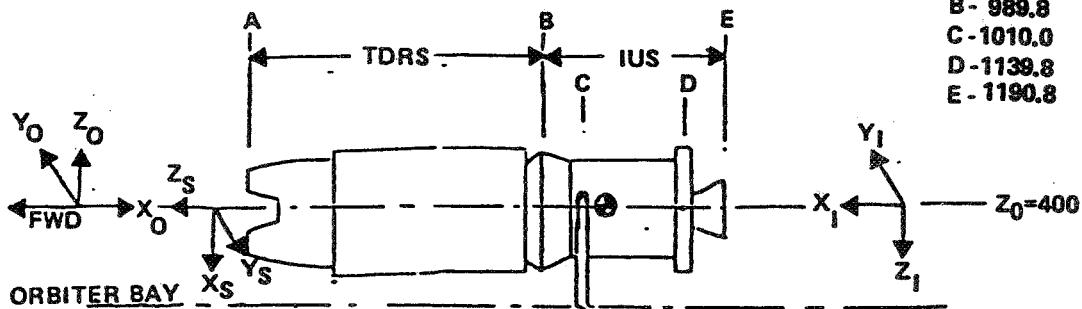


Figure 1 - 1 ASE/IUS/TDRS Mass Properties/Coordinates (Launch)

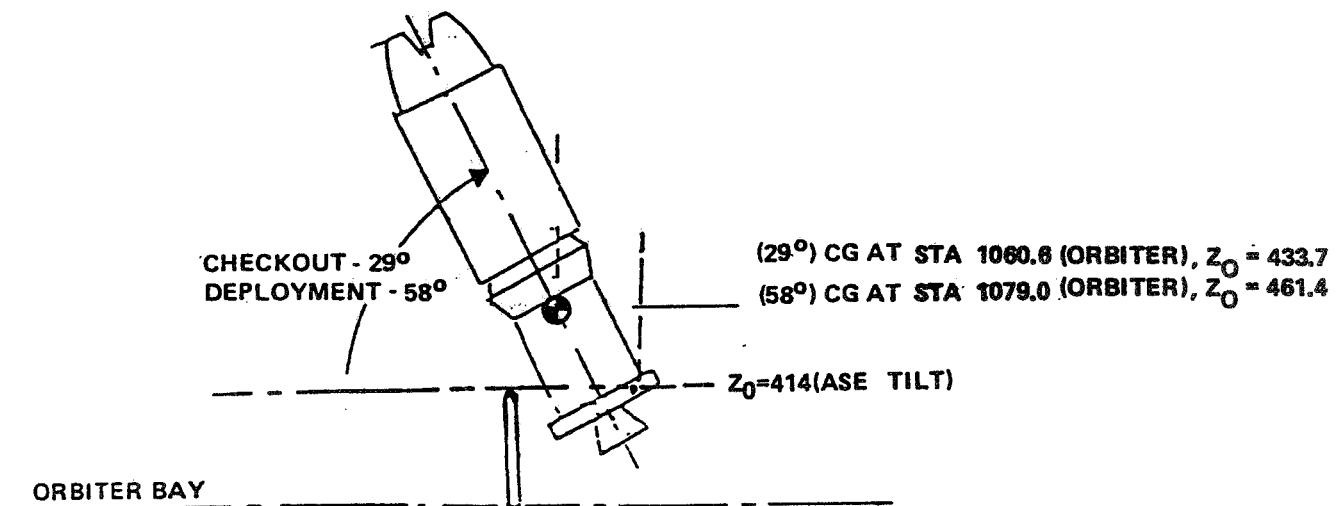


Figure 1 - 2 ASE/IUS/TDRS Mass Properties (Deployment)

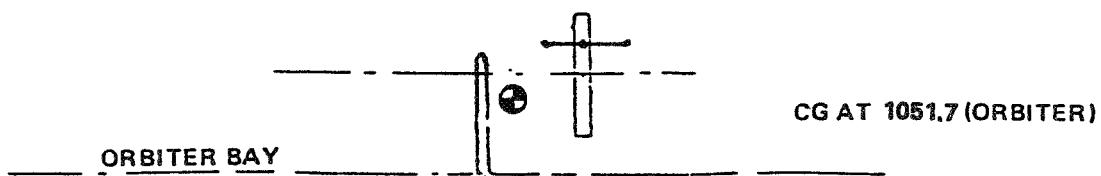


Figure 1 - 3 ASE Mass Properties (Return)

Table 1-1 ASE/IUS/TDRS Mass Property Characteristics

CONFIGURATION	PAYLOAD ELEMENT	WT - POUNDS PROJECTED	WT - POUNDS CONTROL	CENTER OF GRAVITY (INCHES)			M.O.I - FT ²			WT CALC.	WT ACTUAL	WT EST.
LAUNCH	IUS	32,277	-	286.9	-.06	-.41	6,360	17,845	17,870	8%	-	92%
	TDRS	5,000	5,000	454.6	.2	-.4	1,134	1,754	1,784	44%	44%	12%
	ASE - IUS	7,060	-	286.7	-1.6	-1.0	6,481	25,267	28,991			
	ASE - TDRS	-	-									
	ASE - GFE	1,504	/500	459.9	6.0	-13.3	462	7,272	7,657			
	PAYOUT UP	45,841	46,500	310.9	-.11	-.92	14,507	86,550	90,672			
CHECKOUT	ASE/IUS/TDRS	46,841	-	308.2	-.12	-33.7	25,821	88,793	81,574			
DEPLOYMENT	IUS/TDRS	37,277	-	289.8	-.12	-61.4	60,205	95,847	63,893			
	ASE	8,564	-									
RETURN	ASE	8,564		317.1	-.27	-3.2	6,899	40,610	44,692			

NOTE: DATA REFERENCED TO IUS STATIONS/COORDINATES

 DATA REFERENCED TO NON-TILTED IUS COORDINATES

2.0 CONFIGURATION DRAWINGS

The drawings shown as Figure 2-1 thru 2-4 define the payload mechanical configuration.

2.1 Integrated ASE/IUS/TDRS

The integrated payload at launch is illustrated in Figure 2-1 (shown in horizontal position). Specific information is delineated as follows:

- a. Payload Static and Dynamic Volume Envelopes - shown on Figure 2-1.
- b. Drag-on cable locations are required clearances. The ASE and IUS do not require a drag-on cable for checkout. All IUS and ASE functions are verified by the Checkout Station through Orbiter T.O. umbilical connections.
- TDRS requires usage of a drag-on cable assembly for ground checkout prior to P.L. bay door closure. Location of TDRS test connectors for drag-on cable attachment is shown in Figure 2-2.
- c. Grapple Hook - none required. All lifting accomplished as integrated payload using ASE support ring and IUS handling fixture.
- d. Mass Property Coordinate System - shown in Figure 1-1 and 2-1.
- e. STS/Orbiter Interface Locations on Payload - Payload interfaces within the Orbiter are of three types, mechanical, electrical and RF:

1. Mechanical interfaces are basically ASE: a) the Fwd and Aft frame attachments to the Orbiter frame, b) between the Communication Interface Unit (CIU) and its mounting location within the Orbiter equipment and c) between the Power Control Panel and its mounting location in the Orbiter Control area.

The purge air locations are not shown for clarity reasons.

2. Electrical Interfaces are also basically ASE. There are two primary locations, Starboard and Port Standard Mixed Cable Harness (SMCH) Panels. All payload interface cables mate with the Orbiter cables at these two locations which are located on the Orbiter bay wall by the ASE AFT cradle assemblies.
3. R. F. Interfaces - The R.F. interfaces are delineated in paragraph 3.0.

f. Payload Elements:

1. ASE elements consist of those shown in Figure 2-4 in addition to the CIU and Power Control Panel.
2. IUS elements consist of those shown in Figure 2-3.

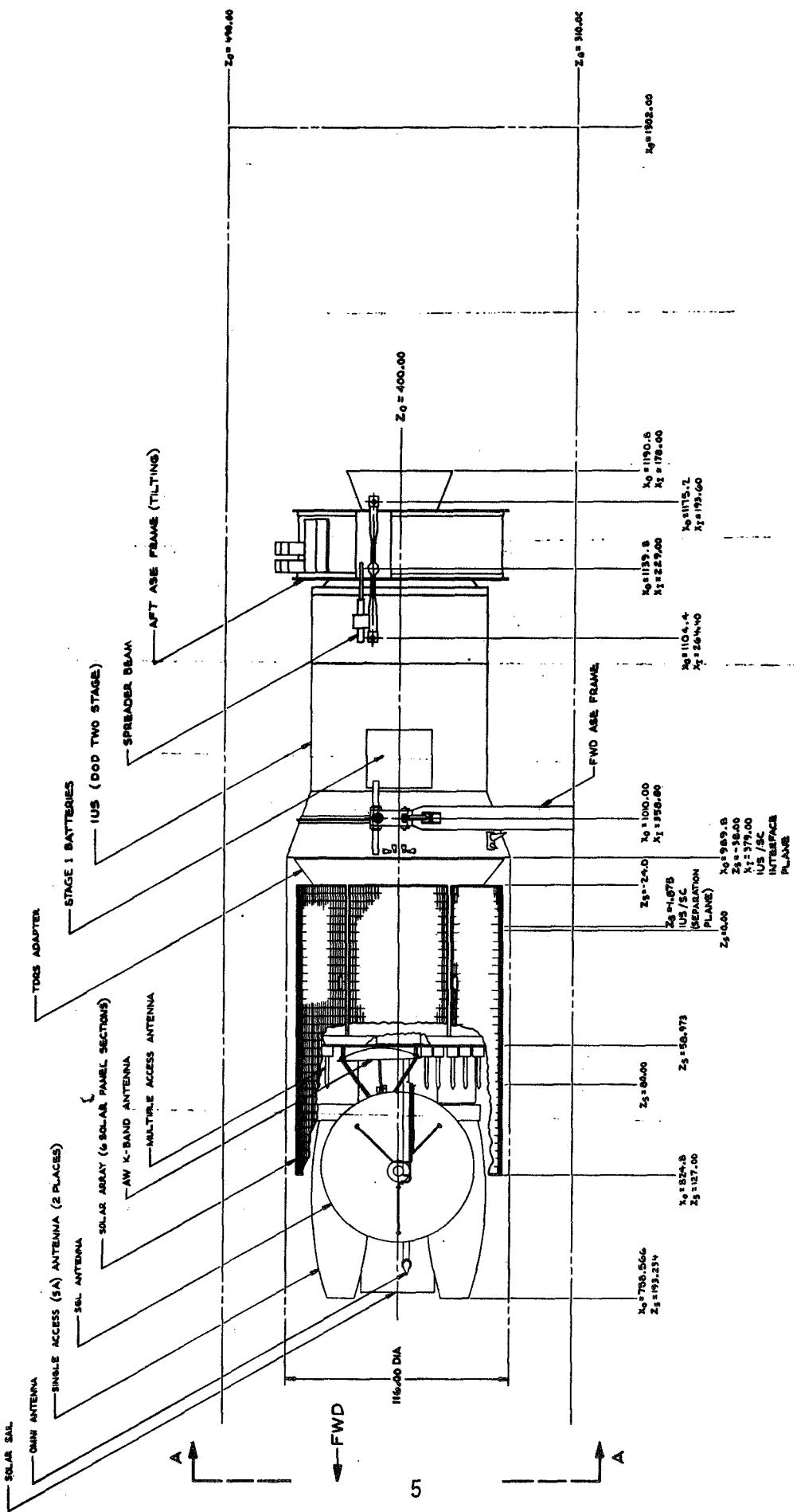


Figure 2-1.- Integrated ASE/IUS/TDRS Configuration.

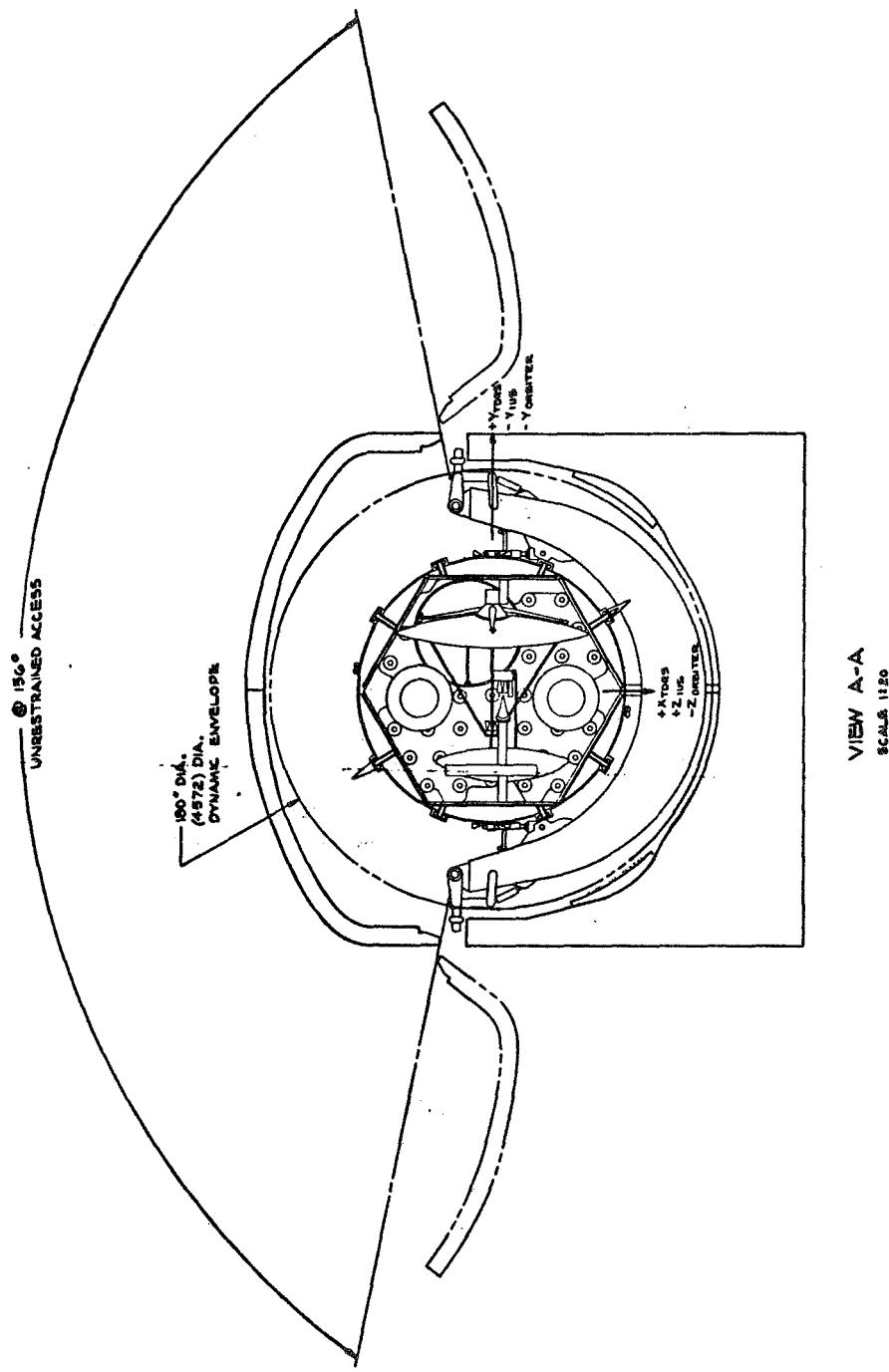


Figure 2-2. TDRS Configuration (View A-A).

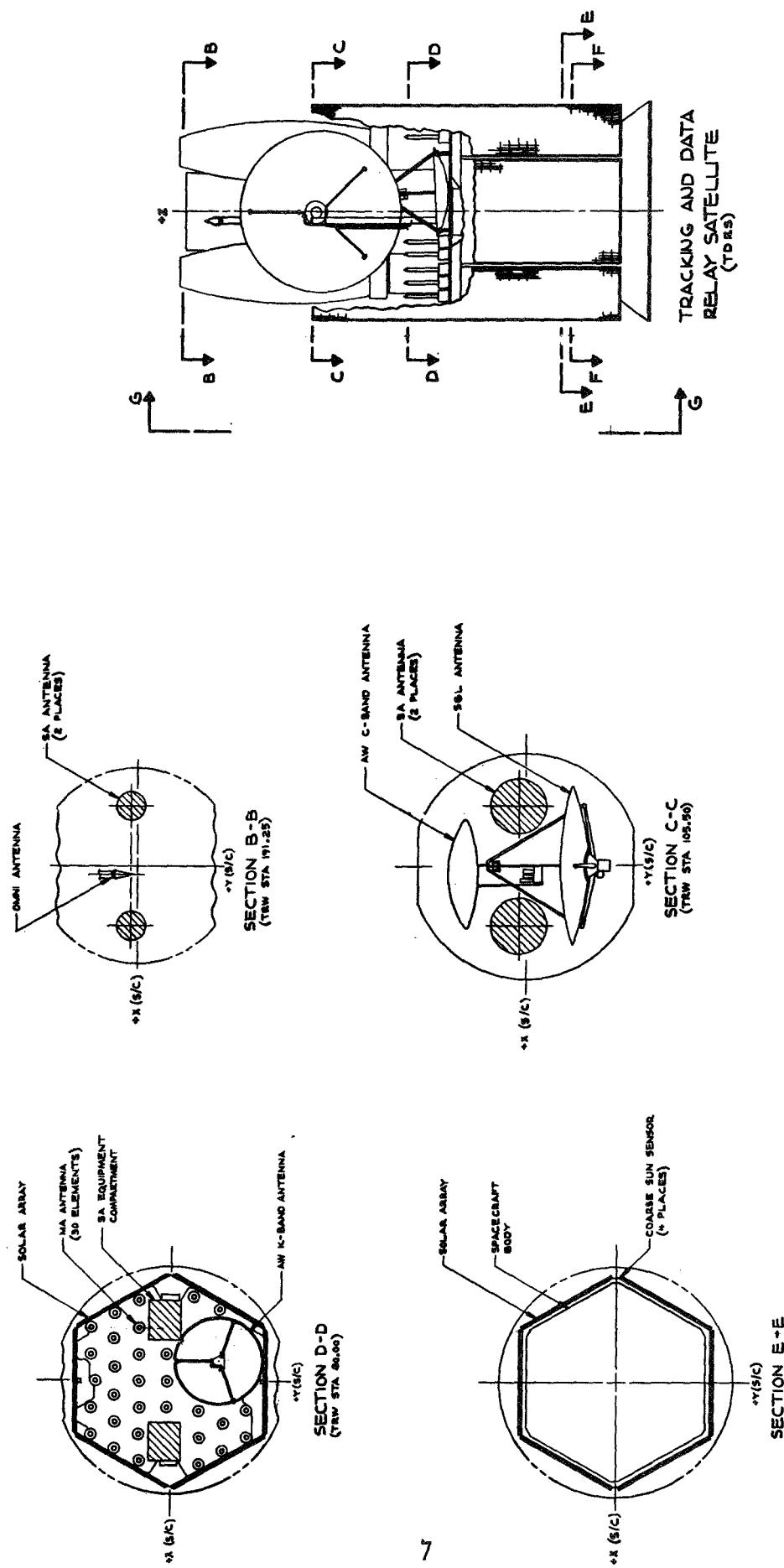


Figure 2-2.- TDRS Configuration.

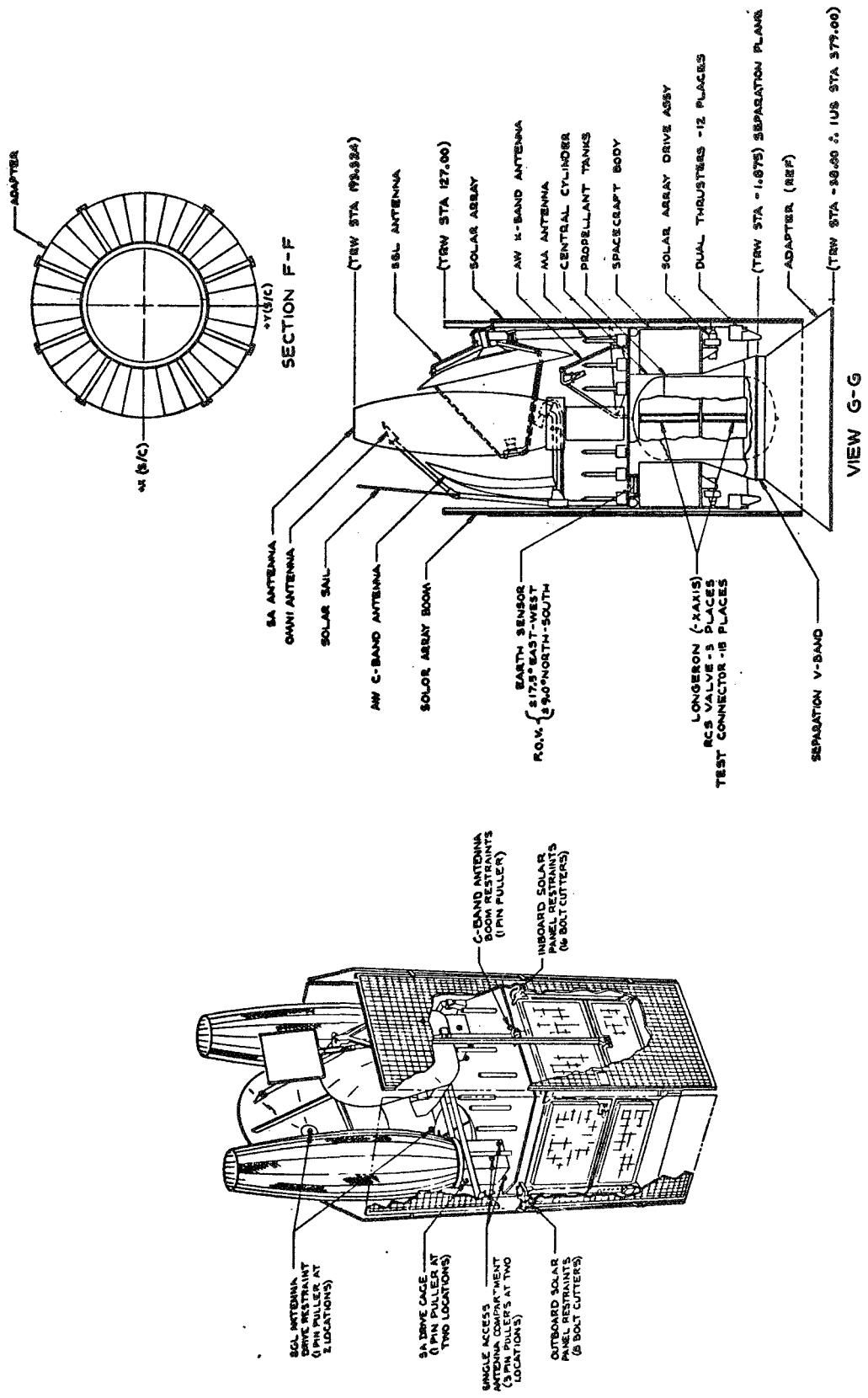


Figure 2-3.- IUS Configuration (Views F-F and G-G).

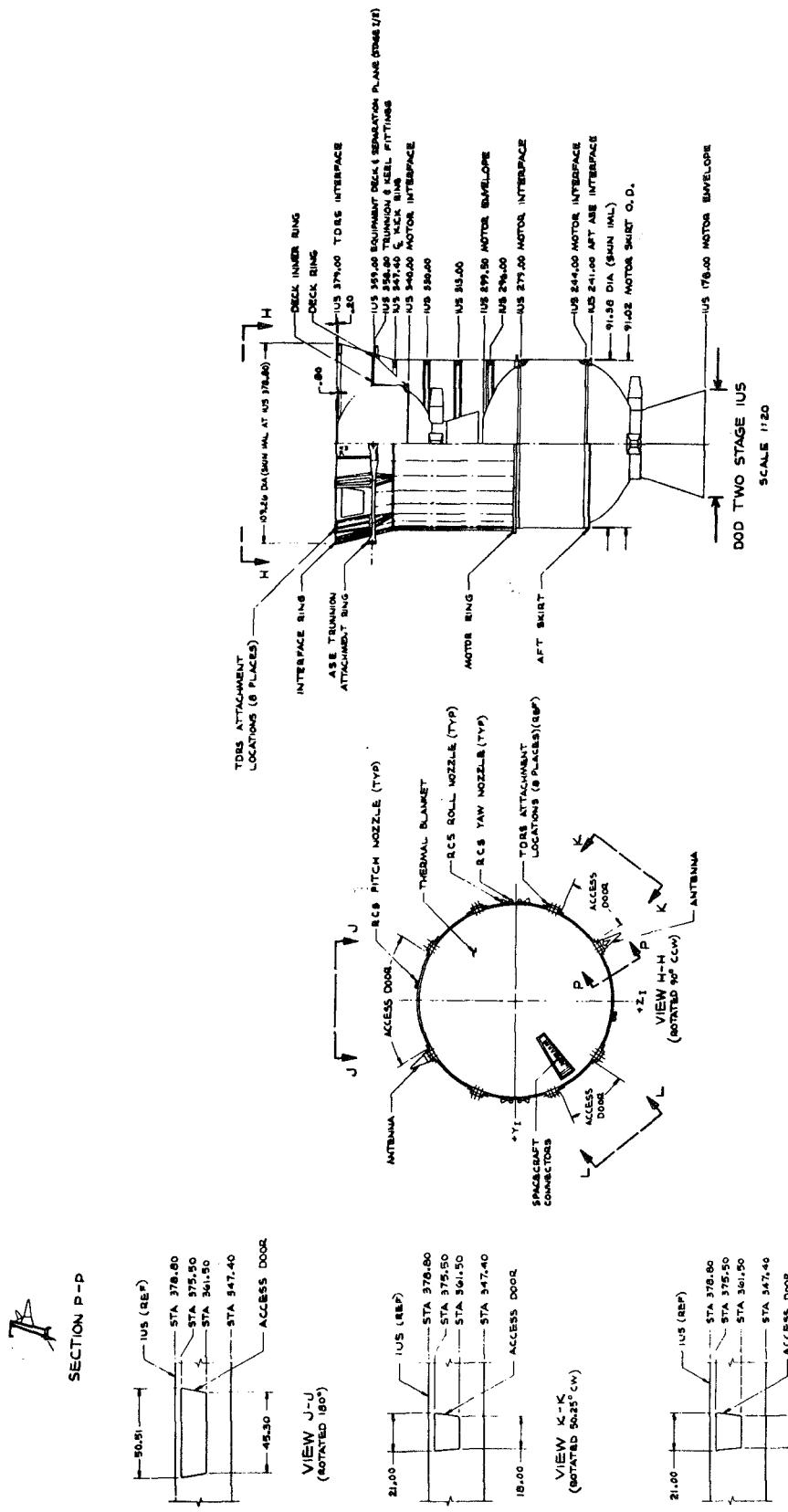


Figure 2-3.- IUS Configuration.

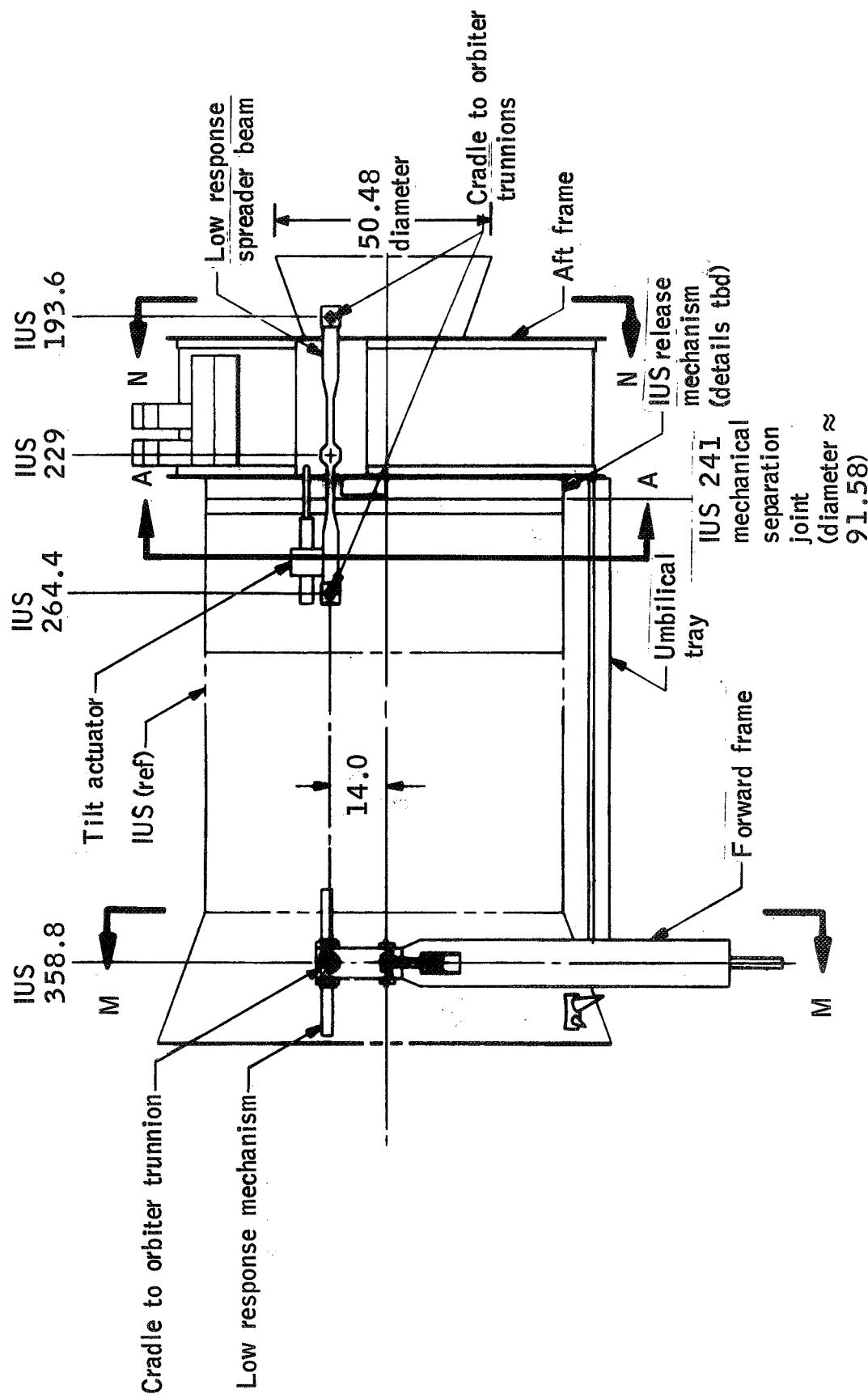


Figure 2-4.- ASE Configuration.

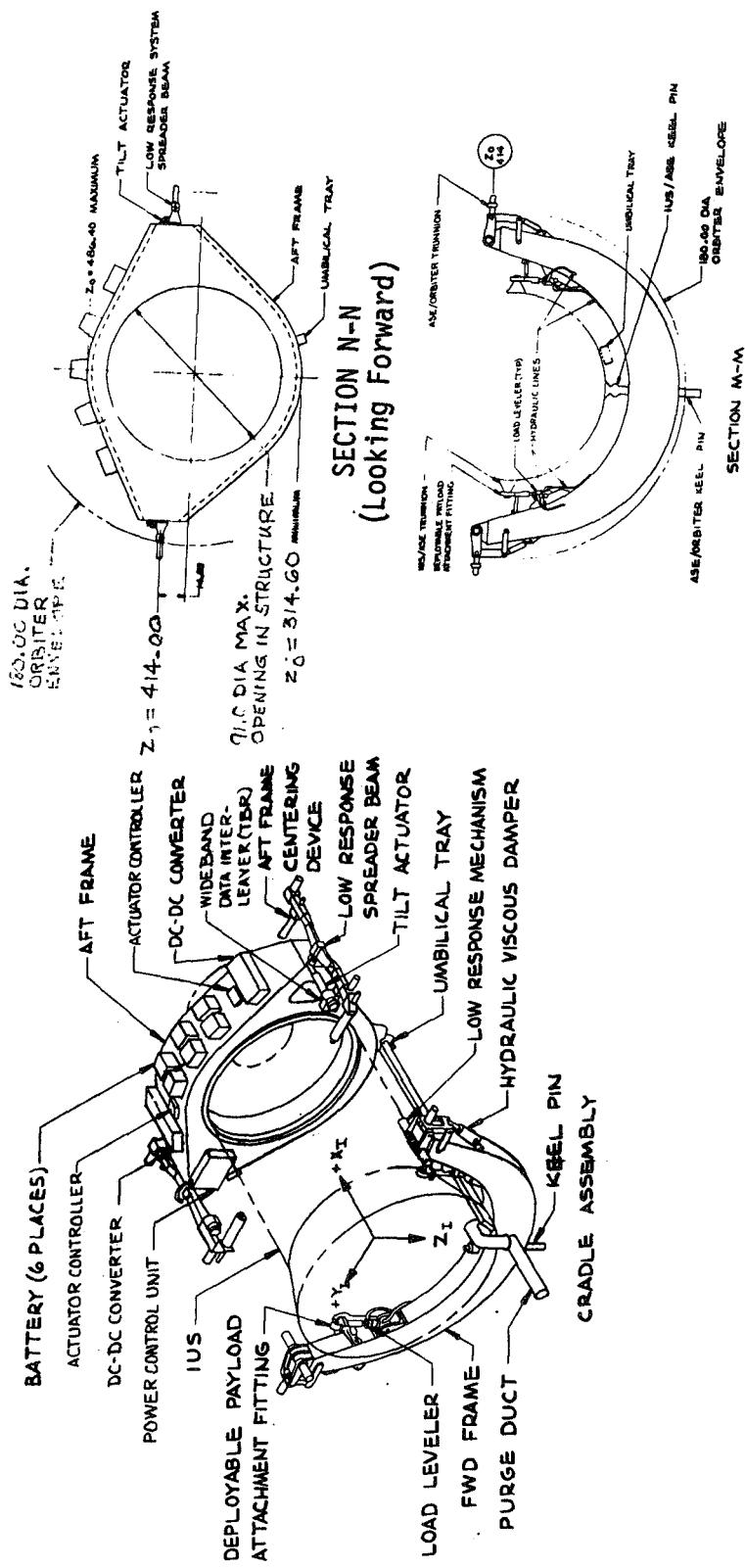


Figure 2-3.- IUS Configuration (Concluded).

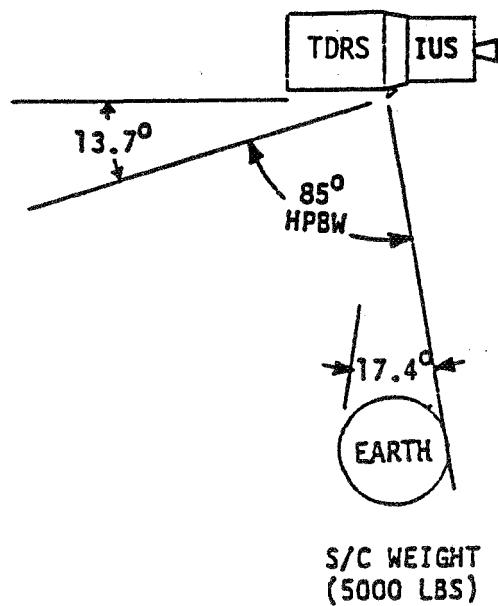
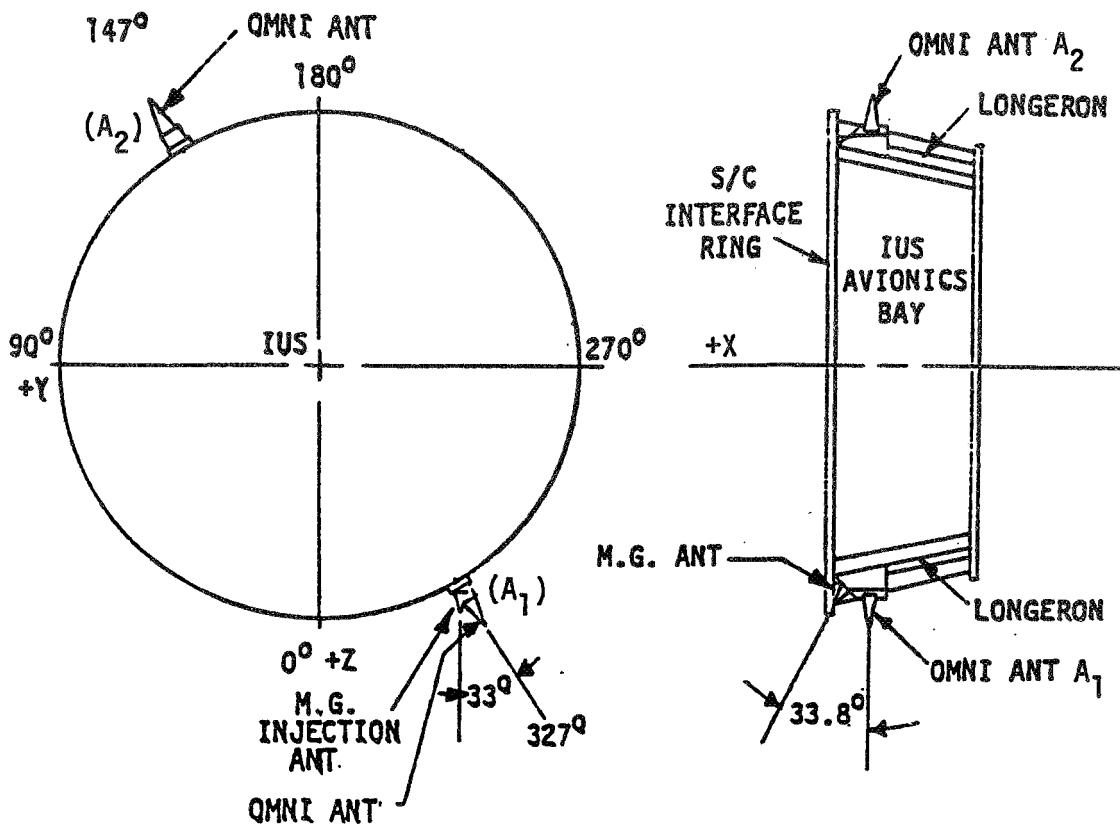


Figure 2-5.- IUS Antenna Implementation for STS/TDRS Geosynchronous Injection Coverage.

3. TDRS Elements consist of those shown in Figure 2-2.
- g. Antennas and their locations - shown in Figures 2-1, 2-2 and 2-3.

3.0 RF RADIATION DATA

3.1 Transmitting System

There are two transmitting systems in the payload. Both the IUS and TDRS have transmitting systems as follows:

3.1.1 IUS Transmission (RF).- The IUS Telemetry Transmitter provides the IUS RF downlink capability to the ground stations during IUS checkout prior to IUS/TDRS deployment and when deployed from the Orbiter. In addition, when within receiving range of the Orbiter Payload Interrogator, the Orbiter R.F. downlinks can be used for IUS Telemetry downlink transmission.

- a. Center frequency: primary 2232.5 MHz (Ch #7), Secondary 2272.5 MHz (Ch #15)
- b. Frequency Deviation: (TBD)
(Stability)
- c. Subcarrier frequency: 1.024 MHz (PCM/PSK) and 1.7 MHz (FM/FM)
- d. Subcarrier Modulation: (See Item C)
 1. Data Rates: 64 and 16 KBPS
 2. Data Type: Bi-Ø-L or NRZ-L
- e. Power Output: 20 Watts Min. to 30 Watts Max. (+43.5 dBm nominal)
- f. Number of Antennas: 2 conical log - spirals, OMNI, (64 KBPS to 500 n.m.)
(16 KBPS to GSO)
1 medium gain (64 KBPS at GSO)
- g. Cable loss to each antenna: IUS Transmit Losses = 
- h. Location of each antenna in payload rectangular coordinates: See Figure 2-3,5.
- i. Antenna gain and polarization: +1.4 dB, nominally RHCP, OMNI on-axis directivity.
- j. Antenna efficiency: $0.7 \pm 0.25\%$
- k. Size of largest antenna element, meters: Not Applicable
- l. Antenna boresight elevation and azimuth tilt angle: (TBD) See Figure 2-3.5

► OMNI A₁ = 3.04dB Nominal
OMNI A₂ = 3.24dB Nominal
Median Gain = 1.77dB Nominal

- m. Ranging transmission: IUS transmitters also provide ranging data turn-around consisting of PRN data at 1.0 MHz during checkout and following IUS/TDRS deployment. This data is not required to be handled by the Orbiter PI.
- n. Antenna coverage: See Figure 2-5.

3.1.2 TDRS Transmission (RF).- The TDRS telemetry transmitter provides TDRS RF downlink capability to STDN during each Orbiter Pass when the IUS/TDRS are erected by the ASE and TDRS +Z axis is pointed towards STDN ($\pm 20^\circ$). The TDRS telemetry transmitter may also be utilized for RF communication to the Ground Via the Orbiter PI when properly oriented for PI reception and within the PI receiving parameters.

a. Transmitter System Name	TT&C Transponder Transmitter
b. Type	
(a) Subcarrier On Carrier	Phase Modulation
(b) Data On Subcarrier	BPSK
c. Center Frequency, MHz	2211.0
d. \pm Deviation, MHz	± 0.080
e. Modulation Frequency (Telemetry Subcarrier), MHz	$1.024 \pm 0.003\%$
f. Pulse Width, μ S	NA
g. Pulse repetition Frequency, pps	NA
h. Output Power, dBw	
1. Deployed	-5.8
2. Undeployed	-8.8
i. Number of Antenna	1 S-Band Omni
j. Cable Loss Between Transmitter and Antenna, dB	5.55

3.2 Receiving System

Both the IUS and TDRS are capable of receiving and processing ground up-link RF commands transmitted via the Orbiter PI when oriented properly and within the Orbiter PI transmission reception range. In addition direct ground to IUS or TDRS command uplink reception will be verified and used

when the IUS/TDRS is in the erected (checkout) position in the Orbiter bay.

3.2.1 IUS Reception (RF)

- a. Center Frequency: Primary 1787.744 - (CH #7), Secondary 1819.775 MHz (CH #1)
- b. Frequency Deviation: .002% of selected frequency (Stability)
- c. Carrier Modulation: PM
- d. Carrier Phase Stability: (TBD) RMS
- e. Subcarrier Frequency: 65, 76, & 95 kHz
- f. Subcarrier Harmonic Distortion: (TBD)
- g. Modulation Index: 0.3 or 1.0 radians
- h. Subcarrier Modulation: (FSK/AM)
 - 1. Logic "1": 95 kHz Tone
 - 2. Logic "0": 76 kHz Tone
 - 3. Logic "S": 65 kHz Tone
- i. Data Rates: DOD IUS USES 1 KBps.
- j. Number of Antennas: Two - See Paragraph 3.1.1
- k. Antenna Polarization: RHCP
- l. Location of Antennas in Payload Retangular Coordinates: See Figure 2-3
- m. Antenna Coverage: See Figure 2-5.

The following receiver data for the IUS receiver are TBD at this time.

System 3 dB bandwidth in MHz.

System 60 dB bandwidth in MHz.

System maximum sensitivity in dBm.

Local oscillator frequency in MHz and amplitude in dBm.

First I.F. frequency in MHz.

First I.F. bandwidth in MHz (3 dB and 60 dB).

Second I.F. frequency in MHz.

Second I.F. bandwidth in MHz (3 dB and 60 dB).

Preselector filter type and maximum attenuation end dB.

Number of poles for preselector filter.

Preselector bandwidth in MHz (3 dB and 60 dB).

Front end low noise amplifier characteristics, if applicable.

Front end RF amplifier characteristics vs. frequency.

Image rejection filter characteristics.

3.2.2 TDRS Reception (RF)

a. Receiver system name	TT&C Transponder Receiver
b. System center frequency, MHz	2035.9625
c. System 3-dB bandwidth, MHz	≥ 3
d. System 60-dB bandwidth, MHz	
1. 1st IF stage (3-pole Chebychev)	7 MHz @ 3dB
2. 2nd IF stage (2 identical BPF, 3-pole Chebychev)	4.5 mHz @ 3dB
e. System Maximum sensitivity (tracking threshold), dBm	≥ -116
f. Local oscillator frequency and amplitude First LO input = 497.475 MHz, $-1 \text{ dBm} \pm 2.5 \text{ dB}$. 1st LO into 1st mixer = 1989.9 MHz @ +9 dBm to +11 dBm. 2nd LO = 32.2625 MHz @ +9 dBm to +11 dBm.	
g. 1st IF frequency, MHz	46.0600
h. 1st IF bandwidth	See item 3.2.2 (d)
i. 2nd IF frequency, MHz	13.8
j. 2nd IF bandwidth, MHz	See item 3.2.2 (d)
k-m. Preselector filter characteristics	NA, Receiver has no preselector filter
n. Number of antennas associated with receiver	1 S-band Omni
o. Cable loss between receiver and antenna, dB	8.95
1. Front end LNA characteristics	NA, Receiver has no preamp.
2. Front end RF characteristics	NA, First module in receiver is a mixer.
p. Image rejection filter characteristics	NA, See "d", Above
q. Maximum "in band" power, dBm.	-40
r. Power to damage receiver at receiver terminals, dBm	10
s. Diplexer loss, dB	4.5

t. Worst case isolation between receiver and transmitter, dB	70
--	----

3.3 TDRS Antenna System

a. Antenna system name	TT&C Antenna
b. Antenna location	See Figure 2-1
c. Other antennas feeding from the same transponder system	AW K-band antenna SGL antenna
d. Antenna gain on boresight	
1. Deployed, dB	-3
2. Undeployed, dB	-6
e. Antenna field polarization	RHCP
f. Antenna effective diameter, m	0.03
	$d_e = \left[\frac{4}{\pi} \cdot G \frac{\lambda^2}{4\pi} \right]^{1/2}$
g. Antenna pointing	See Figures 2-6 & 2-7
h. Antenna efficiency, %	≥ 60
i. Antenna radiation distribution plot	See Figures 2-6 & 2-7
j. Antenna pattern axial ratio, dB	≥ 4
k. Turn-on/turn-off time of transmitter and receiver during orbit checkout, deployment, etc.	NA
l. Selection scheme for multiple antenna system	NA

3.4 TDRS Omni Antenna Coverage (Stowed Case)

Figure 2-6 shows the antenna pattern for a single cut through the X, Z plane. The recommended operating region indicated in the figure is selected to be the angle from the base of the omni antenna to the tips of the two SA antennas. These angles reflected the enlarged SA antenna tip diameters (3.5 inch increase radius).

Figure 2-7 shows the antenna pattern for a cut through the Y, Z plane. The hold between 20 and 30 degrees is caused by reflections off the tip of the SGL antenna. The pattern skew toward the +Y axis is a result of the omni antenna position. That is, the omni antenna is tilted 59 degrees off the +Z axis toward +Y in order to provide the desired coverage in the

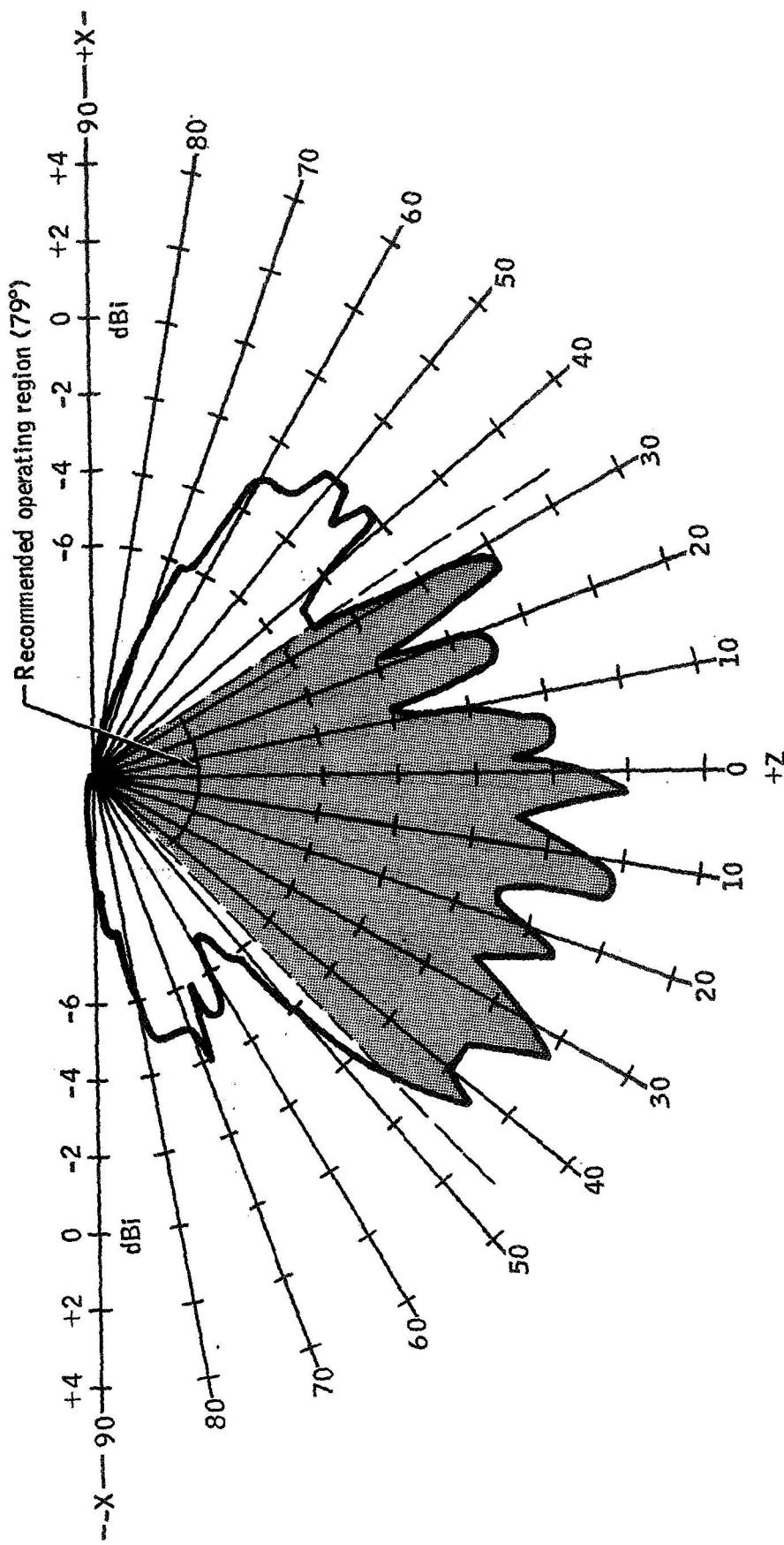
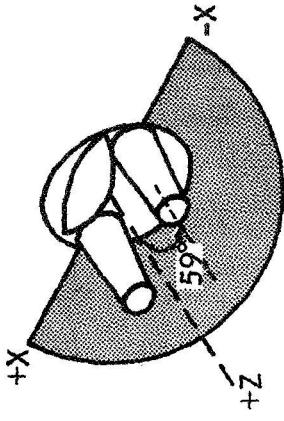


Figure 2-6.- Cut thru XZ plane [stowed case]

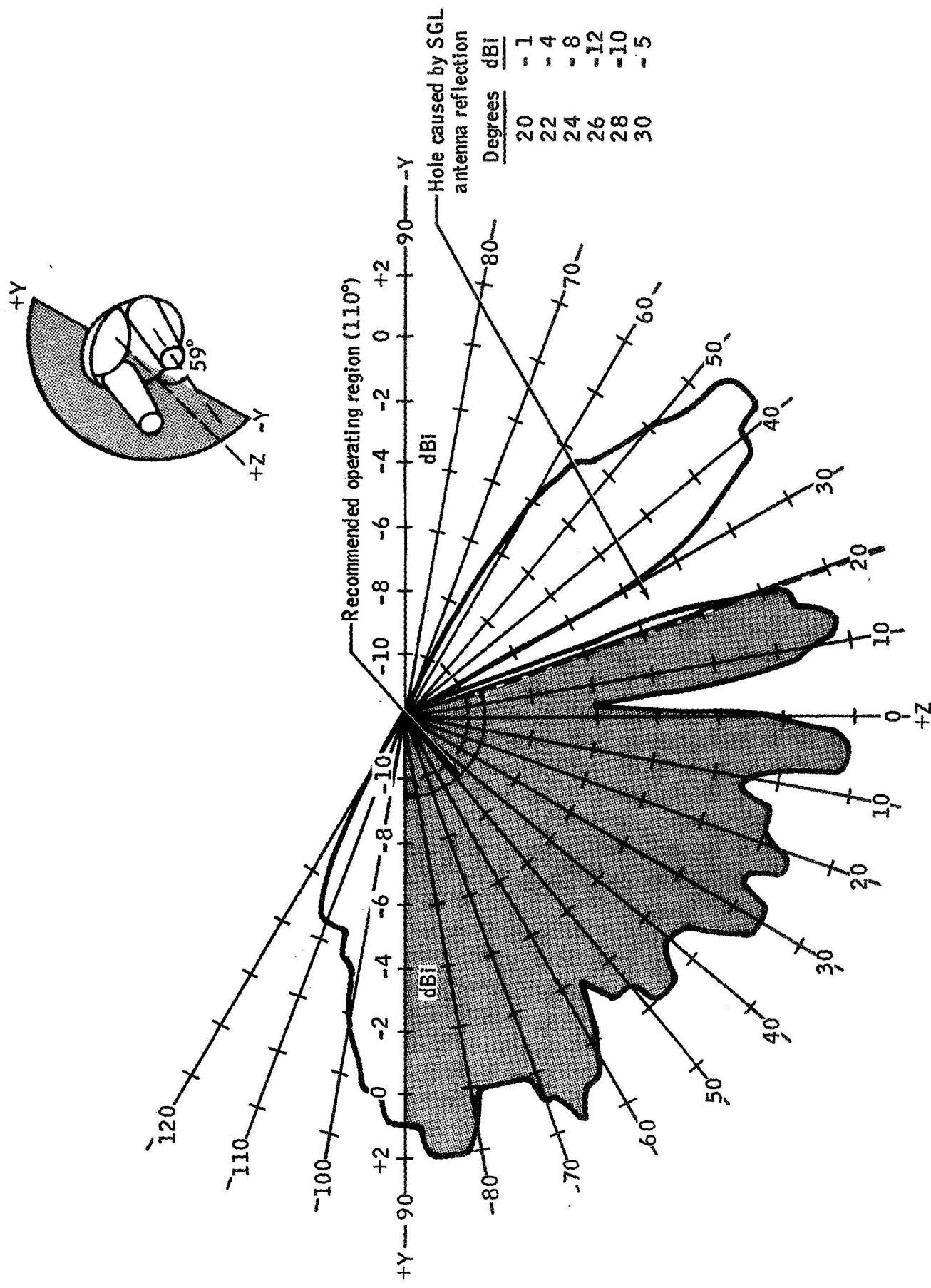


Figure 2-7.-Cut thru YZ plane{stowed case}

deployed spacecraft configuration. The spacecraft +Z axis can be pointed northward by approximately 35 degrees to optimize coverage along this axis.

4.0 TDRS/IUS ERECTION DATA

Table 4-1 reflects the loads transmitted to the ASE aft ring support locations during erection from 0 to 29° and from 29° to 58°. The ASE erects at approximately 0.10/seconds (about 1.5 seconds is required for initial acceleration and the same for deceleration). Total time is approximately 280 seconds for 29° travel.

PAYLOAD ERECTION DATA

TABLE 4-1

POSITION	Z-LOAD (LBS)	
	IUS-STA. 264.4	IUS-STA. 193.9
0° (start)	+ 56	- 82
29° (stop)	-118	+165
58° (stop)	-127	+155

4.1 IUS Deployment Data

Deployment of the IUS/TDRS is with the ASE tilted at 58°. The IUS/TDRS clears the aft ASE ring in approximately 12 seconds following deployment initiation and is moving at a relative velocity (with respect to the Orbiter) of 0.4 fps.

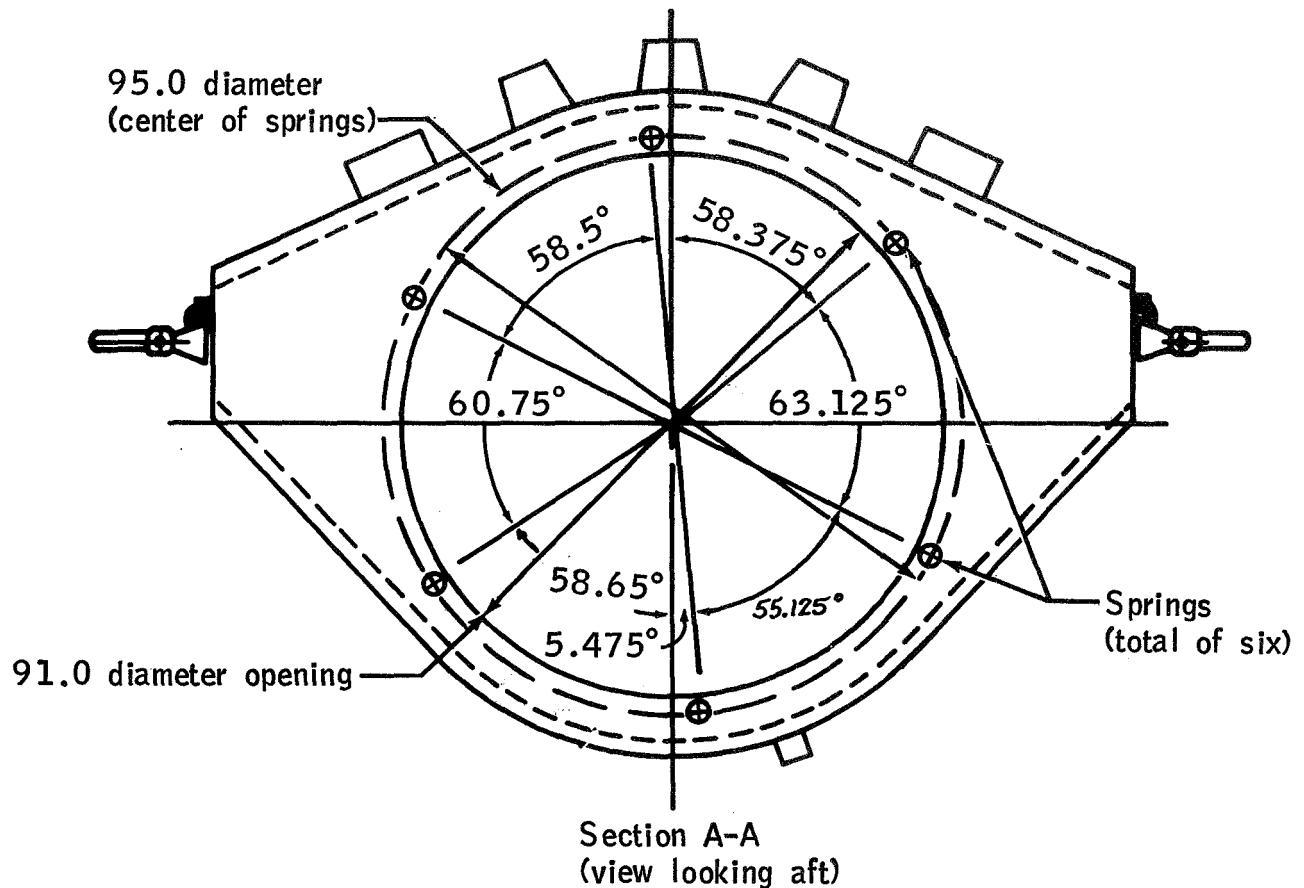
5.0 ATTITUDE INITIALIZATION

The IUS star-scanner F.O.V. orientation with respect to the Orbiter is shown in Figure 5-1.

Star coincidence and magnitude signals upon detection of a star are obtained by rotating the Orbiter (IUS stowed configuration) about the X_0 axis at a nominal rate of 0.5 deg/sec.

These signals are used by the IUS computers to provide an attitude update. Detection of two stars 60 to 120 degrees apart provides an IUS 3-axis update. The field of vision of the star-scanner can accommodate IUS attitude uncertainties in true position of $\pm 2^\circ$.

The star catalog, Table 5-1, is provided although each individual IUS vehicle will be programmed to use mission-peculiar subsets (TBD) of the total star catalog. Stars must be at least 30° from the sun to 15° from the earth or moon.



Spring rate = 30 lbs per inch
 Spring initial deflection = 3.9 inches
 Spring final deflection = 0.9 inches
 Total spring travel = 3.0 inches
 Springs contact IUS at IUS 243.21 at initial deflection

Figure 4-1.- Ejection Spring Locations.

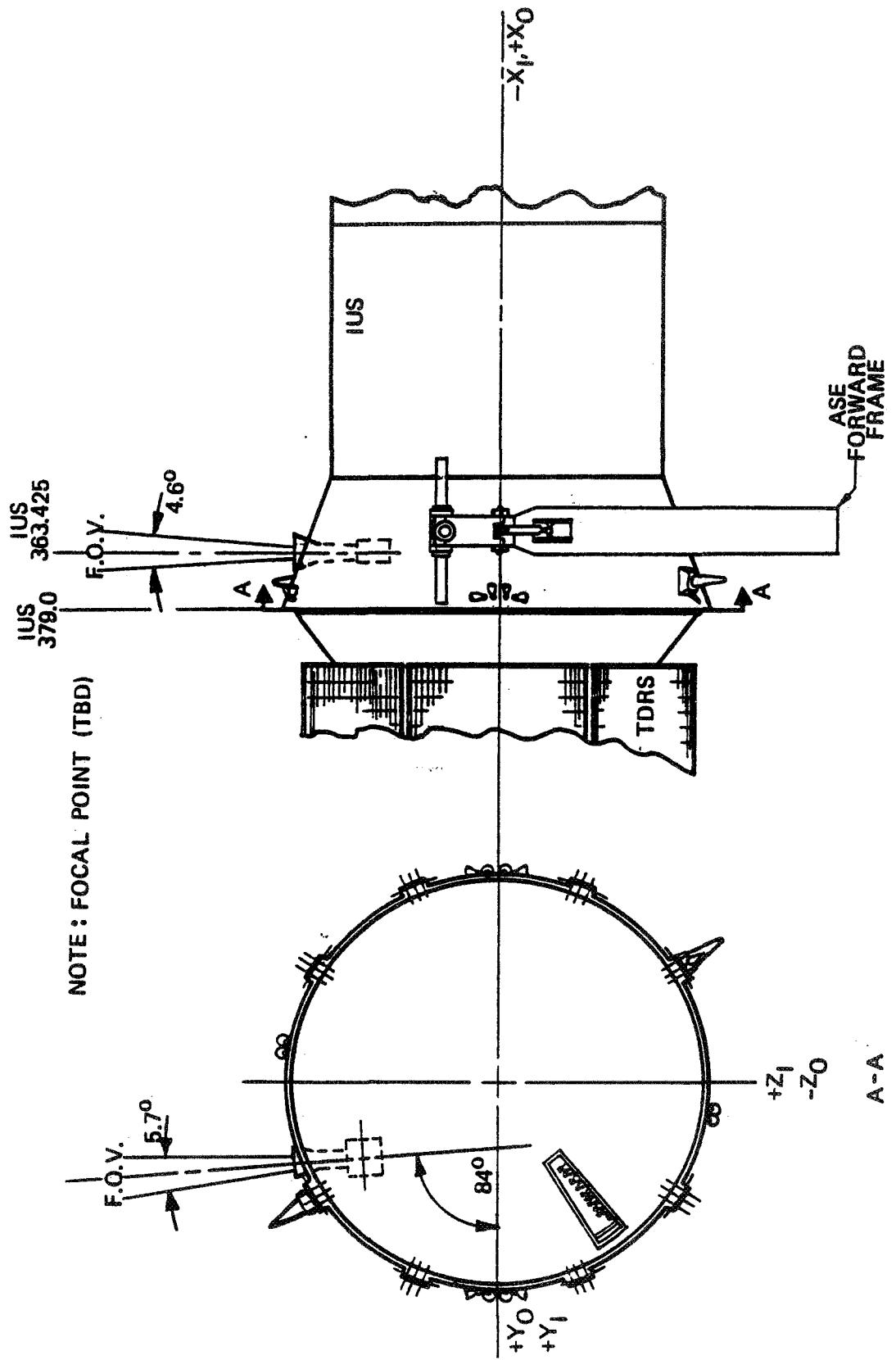


FIGURE 5-1 STAR SCANNER F.O.V. ORIENTATION IN STS

IUS STAR CATALOG
IN ORDER OF BASD NUMBER

TABLE 5-1

BASD #	BS#	NAMES	RAS (RADIAN)	DEC (RADIAN)	MAGNITUDE	REMARKS
1	2491	SIRIUS	1.7601	-0.2908	-1.35	
2	2061	BETELGEUSE	1.5402	0.1291	-0.83	VARIABLE
3	2326	CANOPUS	1.6742	-0.9192	-0.77	
4	5240	ARCTURUS	3.7254	0.3383	-0.56	
5	5459	RIGIL KENTAURUS	3.8314	-1.0597	-0.46	DOUBLE, VAR.
6	6134	ANTHRES	4.3092	-0.4601	-0.23	VARIABLE
7	1708	CAPELLA	1.3692	0.8022	-0.16	
8	7001	VEGA	4.8677	0.6763	0.10	
9	1457	ALDEBARAN	1.1938	0.2868	0.11	
10	1713	RIGEL	1.3639	-0.1439	0.20	
11	2943	PROCYON	1.9949	0.0938	0.26	
*12	4763	GACRUS	3.2703	-0.9936	0.41	
13	1492		1.2060	-1.0884	0.50	VARIABLE
14	8636	B GRUIS	5.9380	-0.8208	0.56	
15	472	ACHERNAR	0.4214	-1.0018	0.57	
16	5267	HADAR	3.6726	-1.0508	0.71	
17	7557	ALTAIR	5.1871	0.1539	0.75	
18	2990	PULLUX	2.0197	0.4907	0.83	
*19	681		0.5990	-0.0549	0.92	VARIABLE
*20	4730		3.2502	-1.0983	0.93	
21	6406	RAS ALGETHI	4.5064	0.2519	0.94	VARIABLE
*22	5056	SP ICA	3.5041	-0.1911	1.08	VARIABLE
23	337	MIRACH	0.2945	0.6181	1.22	
24	8728	FOMALHAUT	6.0034	-0.5198	1.22	
25	3307	AVOIR	2.1903	-1.0370	1.22	
26	8775		6.0292	0.4863	1.25	VARIABLE
27	7924	DEWEP	5.4105	0.7877	1.28	
28	3634	AL SUHAIL	2.3732	-0.7560	1.34	
*29	4853		3.3423	-1.0390	1.39	
30	6217	ATRIA	4.3873	-1.2039	1.41	
31	3748	ALPHARD	2.4678	-0.1480	1.46	
*32	3982		2.6450	0.2123	1.47	
33	4301	DUBHE	2.8854	1.0815	1.47	
34	5563	KOCHAB	3.8868	1.2970	1.49	
35	6705	ELTAMIN	4.6936	0.8988	1.54	
36	911	MENKAR	0.7862	0.0686	1.56	

*NOT USABLE FOR IUS

DISTRIBUTION LIST FOR PAYLOAD INTEGRATION PLAN
COMPLETED ANNEX JSC 14019 Annex 1

STANDARD DISTRIBUTION

NASA JSC

BT/W. Draper
CA/J. F. Honeycutt
CA7/N. T. Buras
CB/Payloads
CF3/M. G. Kennedy
CG3/D. L. Dahms
CG5/T. A. Guillory
CG5/B. Ferguson
CG5/J. A. Wegener
CH/C. S. Harlan
CH6/B. L. Kyle
EA3/R. S. Sayers
EA8/L. E. Bell
EC/D. W. Morris
EE4/W. E. Perry
EH13/C. D. Levy
EH2/T. W. Eggleston
ES/D. H. Greenshields
ES/D. C. Wade
ES12/R. J. Wren
ES2/B. W. Holder
ES3/R. G. Brown
ES5/M. W. Steinthal
EW/W. W. Petynia
EW52/C. D. Perner
FA/S. D. Sanborn
FM2/E. C. Lineberry
FM4/H. B. Beck
FE/S. Faber
FR/J. Broadfoot
FS5/J. L. Parker
FS15/E. Clayton
FS15/T. A. Stuart
JM61/F. D. Goodson (5)

JM86/Remainder

LM/A. Bishop
LT/R. Kohrs
NS2/B. J. Miller
PA/G. S. Lunney
PF/L. S. Nicholson
PF/H. M. Scott
PH/L. G. Williams
PL/C. B. Peterson
SC3/S. Hardee

WC/M. A. Collins

WC/CMO

WC2/D. H. Cordiner

WC6/E. D. Murrah

WT/R. A. Colonna

WT3/Z. K. Eubanks

GSFC

M. S. 470/R. Goss

KSC

CP-PCO/J. C. McBrearty

CS-OMO/R. E. Reyes

Rockwell - Houston

ZC01/Don Hass

Rockwell - Downey

FA89/Data Management (25)

TRW - Houston

O. Bergman

UNIQUE DISTRIBUTION

PF/Project Engineer

W. Hungerford

WC/Integration Engineer

W. Waln

Systems Engineer

PH/L. G. Williams

Payload Officer

CH6

For additions, deletions, or corrections to this distribution list,
please notify WC2/L. M. Brubaker or WC2/M. F. Crocker, NASA JSC,
telephone 713-483-5565.